

Culvert Design Process

Hydrology



Site Assessment



Alignment and Profile



Bed and Banks



Structure



Sediment Mobility & Stability



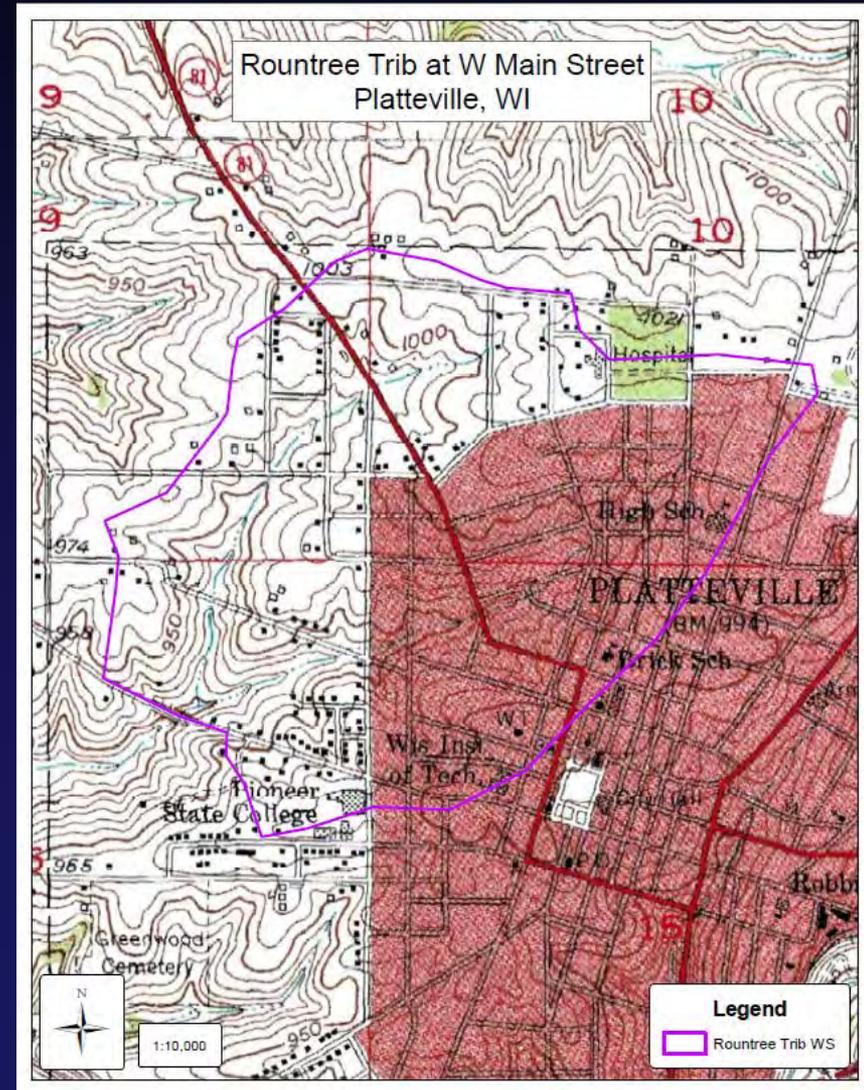
Site assessment

- Initial Site Assessment
- Field Survey
- Site Check-list
- Reference Reach

Initial site assessment

Use existing information

- Maps
- Aerial photos
- GIS layers
- Local experts: resource and transportation agencies



Initial site assessment

ID important concerns and survey requirements

- Passage: other potential barriers to check/verify
- Road considerations:
 - right-of-way,
 - types of vehicle use,
 - maintenance problems,
- Channel morphology:
 - possible downstream headcuts,
 - upstream sediment sources and transport,
 - reference reach,
 - impacts of the crossing



Initial site assessment

Develop preliminary objectives

- Passage:
 - fish,
 - other aquatic sp,
 - terrestrial
- Road design standards:
 - vehicle size and load,
 - speed,
 - safety,
 - maintenance
- Channel morphology:
 - alignment,
 - restoration



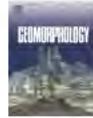
Bankfull (BF) Channel Geometry Relations



ELSEVIER

Geomorphology

Volume 108, Issues 3–4, 15 July 2009, Pages 292–311



Downstream variation in bankfull width of wadeable streams across the conterminous United States

John M. Faustini ^a, Philip R. Kaufmann ^b, Alan T. Herlihy ^a

- Relate drainage area to BF channel dimensions
- Allow “office” estimates of BF width and depth
- Provide a starting point for field determination of BF
- Have scatter due differences in runoff rates and landforms



Prepared in cooperation with the Michigan Department of Environmental Quality, Michigan Department of Transportation, U.S. Army Corps of Engineers, and U.S. Fish and Wildlife Service

Estimated Bankfull Discharge for Selected Michigan Rivers and Regional Hydraulic Geometry Curves for Estimating Bankfull Characteristics in Southern Michigan Rivers



Scientific Investigations Report 2009–5133

VOL. 37, NO. 3

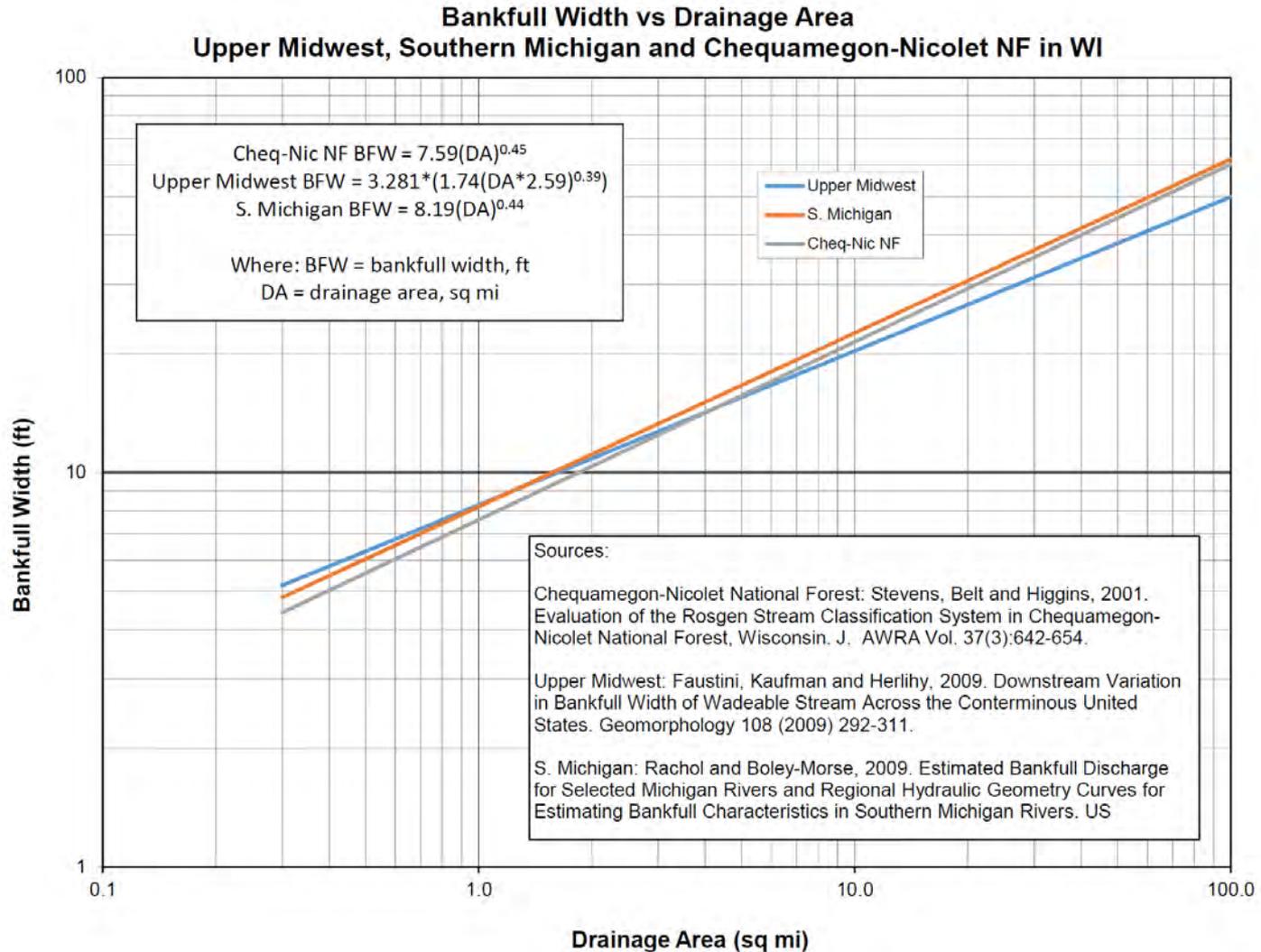
JOURNAL OF THE AMERICAN WATER RESOURCES ASSOCIATION
AMERICAN WATER RESOURCES ASSOCIATION

JUNE 2001

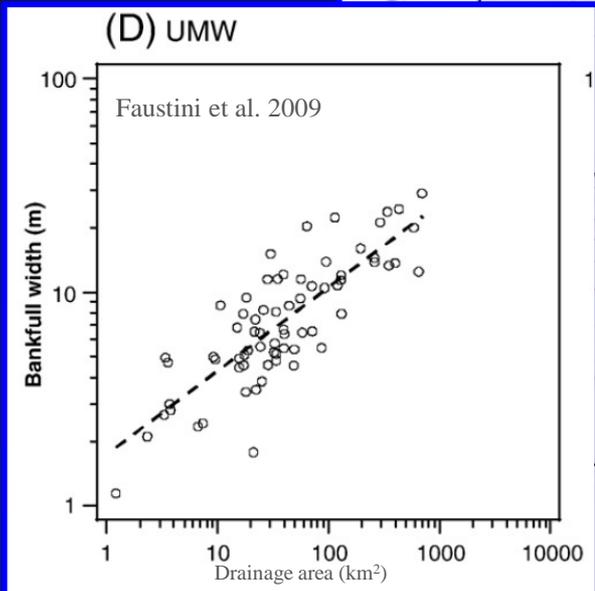
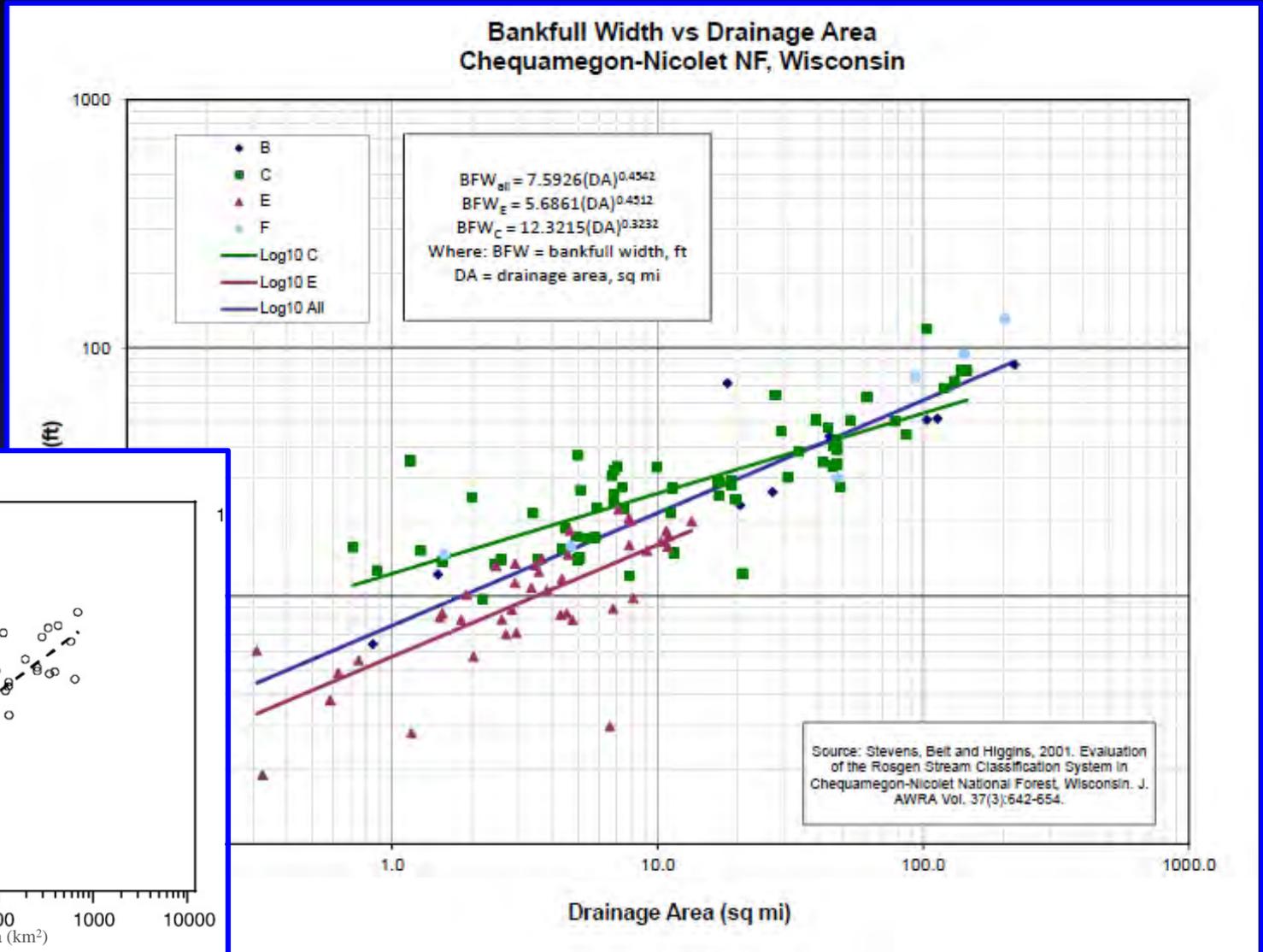
**EVALUATION OF THE ROSGEN STREAM CLASSIFICATION SYSTEM
IN CHEQUAMEGON-NICOLET NATIONAL FOREST, WISCONSIN¹**

Theresa Stevens Savery, George H. Belt, and Dale A. Higgins²

Channel Geometry Relations



Bankfull Channel Geometry Relations

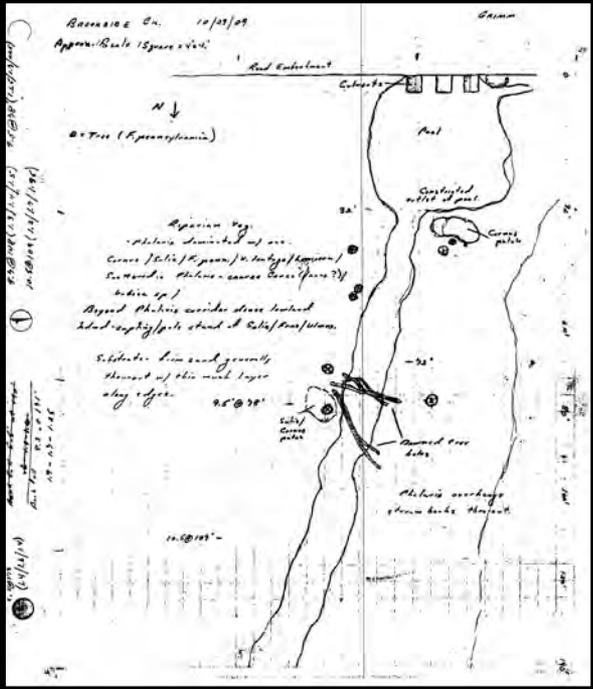




Field survey



- Benchmark
- Stream profile (20-30 ch widths)
- Stream x-sec (min 2 up, 3 dn)
- Road profile (and x-sec)
- Plan view sketch, or
- Topo survey w/total station
- Reference reach
- Geotechnical investigation

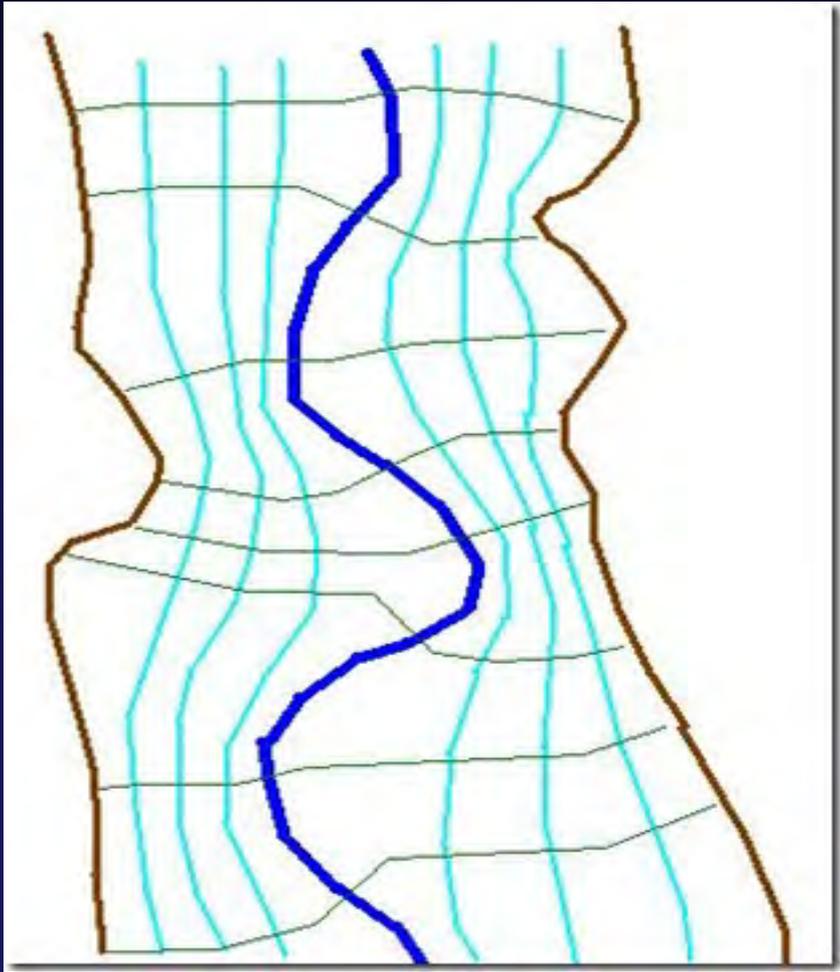
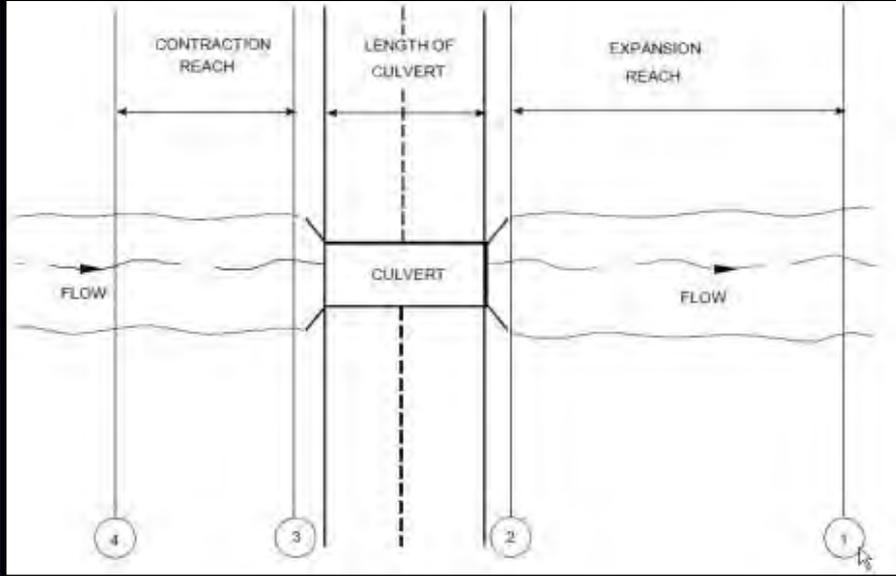




Cross-sections



- Cross floodplain and channel at right angles



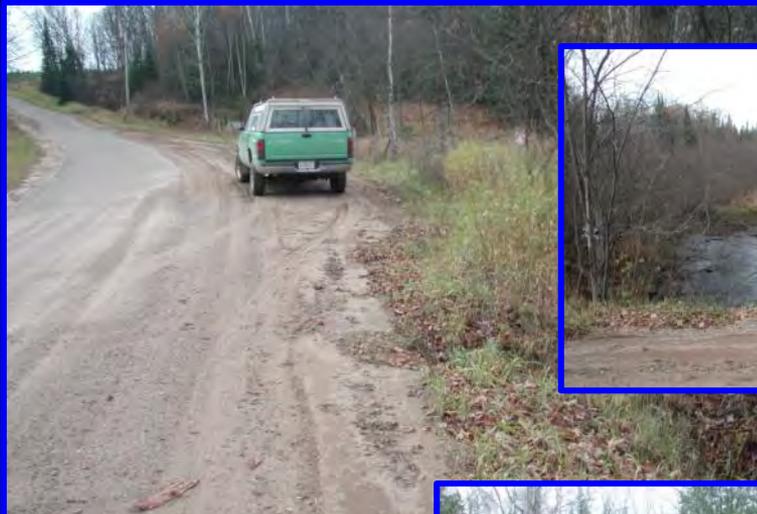


Alignment

Also fish passage,
utility, R-of-W
and reference reach
concerns



Fish passage, sediment, safety, channel restoration, historic concerns



Preliminary geotechnical investigation

- Characterizes material below the channel.
- Identifies subsurface conditions that may require further geotechnical analysis.
 - Clay soils
 - Organic-rich material
 - Saturated material
 - Bedrock
- Needed for design of structure and foundation.

Geotechnical investigation for soils

- Soil auger-portable or hand shovel: describe materials
- Drive probe: estimate density and thickness of units
- Soil borings: identify types and bearing capacity of subsurface units



AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE TEST BORING LOG

ACT JOB NO: 07-04546.8 LOG OF BORING NO: 10-02 (p. 1 of 1)

PROJECT: Chequamegon-Nicolet NF Culvert Replacement - Lilyard Creek, Eagle River, WI

DEPTH FEET	SURFACE ELEVATION: <u>102.8</u>	GEOLOGY	HC	SEC	SAMPLE TYPE	SEC ES	FIELD & LABORATORY TESTS
MATERIAL DESCRIPTION:							WC DD LL PL 4-w-219
1	FILL, sand with silt and gravel, brown			M	SU		
2	FILL, silty sand, a little gravel, grayish brown	FILL	8	M	SS	15	
4	FILL, a mixture of sand, peat, and silt, gray; brown and black						
5	ORGANIC SANDY SILT, trace roots, dark gray and black (CL)	FINE ALLUVIUM					
6							
7	SILTY SAND, fine to medium grained, trace roots, dark grayish brown, wet, loose (SM)		10	W	SS	11	
9	SAND WITH SILT, fine to medium grained, dark grayish brown, wet, loose, lenses of fine to medium grained sand below about 11.5' (SP-SM)		8	W	SS	12	
10							
12			8	W	SS	10	
14	SAND, a little gravel, fine to coarse grained, brown, wet, medium dense, gravel lenses between about 16 and 19' (SP)	COARSE ALLUVIUM	12	W	SS	7	
15							
16							
17							
18							
19							
20			10.7				
21			10.7				
22							
23	SILTY SAND, a little gravel, brown, wet, medium dense (SM)		17	W	SS	1	
24							
25							
26	END OF BORING AT 26.0 FEET Bottle back-filled with bentonite grout						

DEPTH	DRILLING METHOD	WATER LEVEL MEASUREMENTS						NOTE REFER TO
		SAMPLED	CAUSE	CAUSE	DEPTH	DATE		
		DEPTH	DEPTH	DEPTH				
0.94'	3.25" HSA						THE ATTACHED	
9.0-24.0'	ED w DM	5/18/10	16:30	8.5	7.0	7.6	SHEETS FOR AN	
							EXPLANATION OF	
							TERMINOLOGY OR	
							THIS LOG	

BOREING
CONDUCTED: 5/18/10
BY: MD LG TDD EJR SAR

06/06

Selection of reference reach

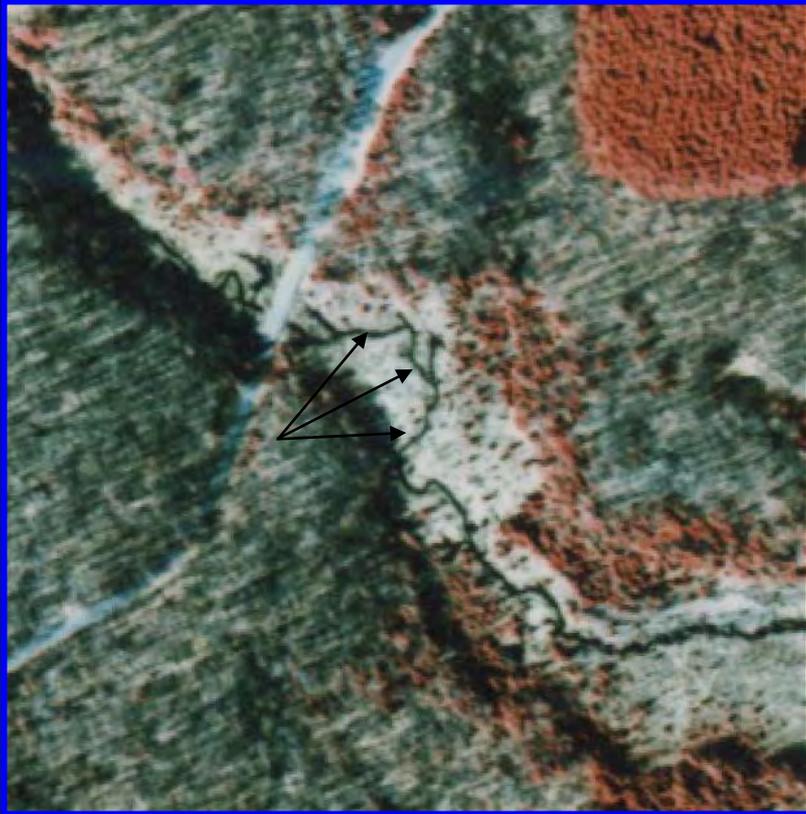
- Represents project channel
 - Primarily selected by project gradient
- Provides “input” to stream simulation
- Out of the influence of existing crossing
- Try to avoid very complex channels



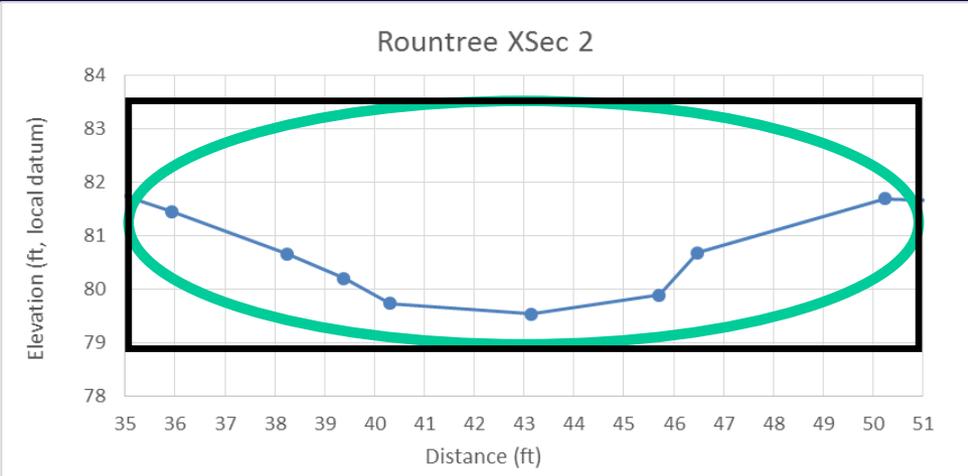
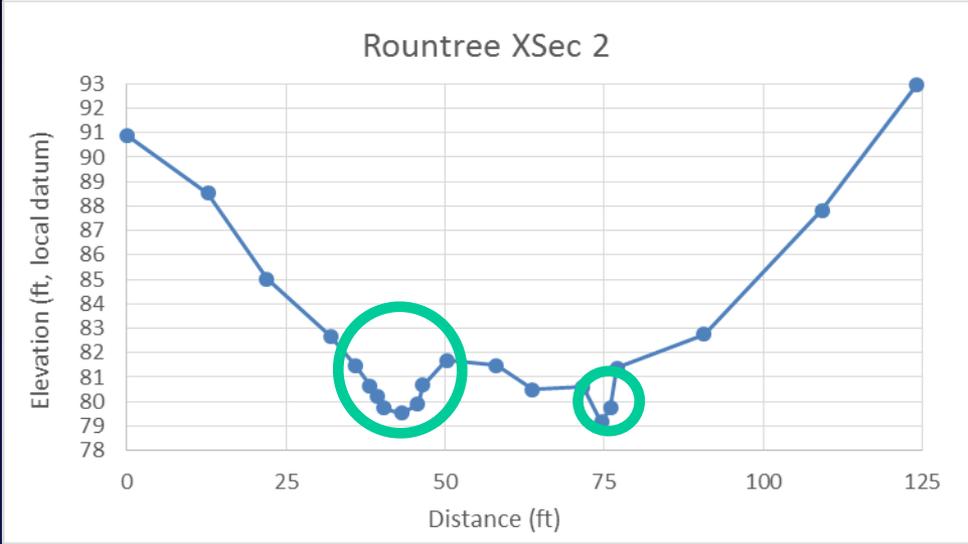
Reference reach measurements

- Pattern (site sketch)
- Variability/controlling structures (site sketch, key pieces measurements)
- Slope (profile survey)
- Dimensions (cross-section survey, bankfull measurements)
- Substrate (pebble count)
- Photos/video

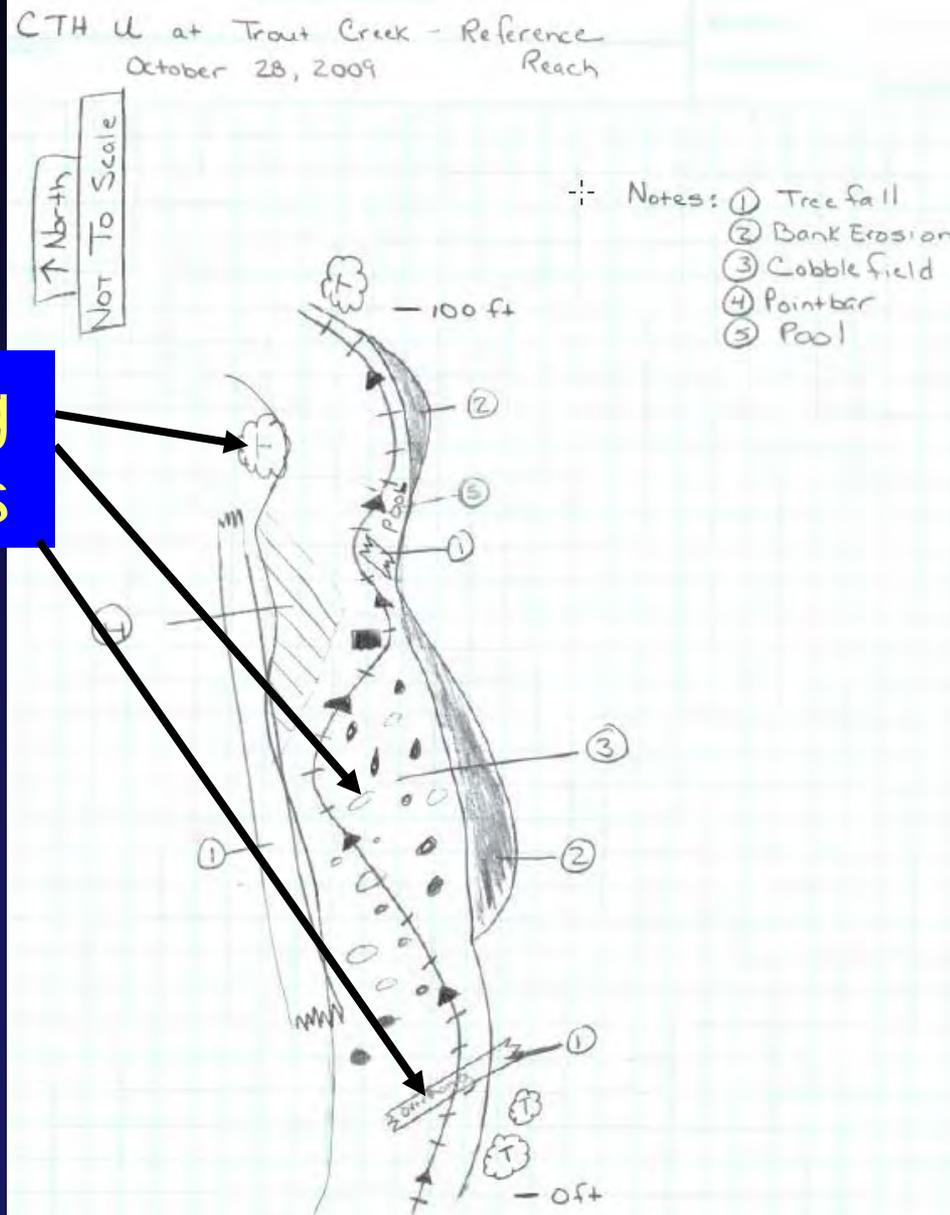
Selecting a reference reach for bankfull width measurements



Cross-sections



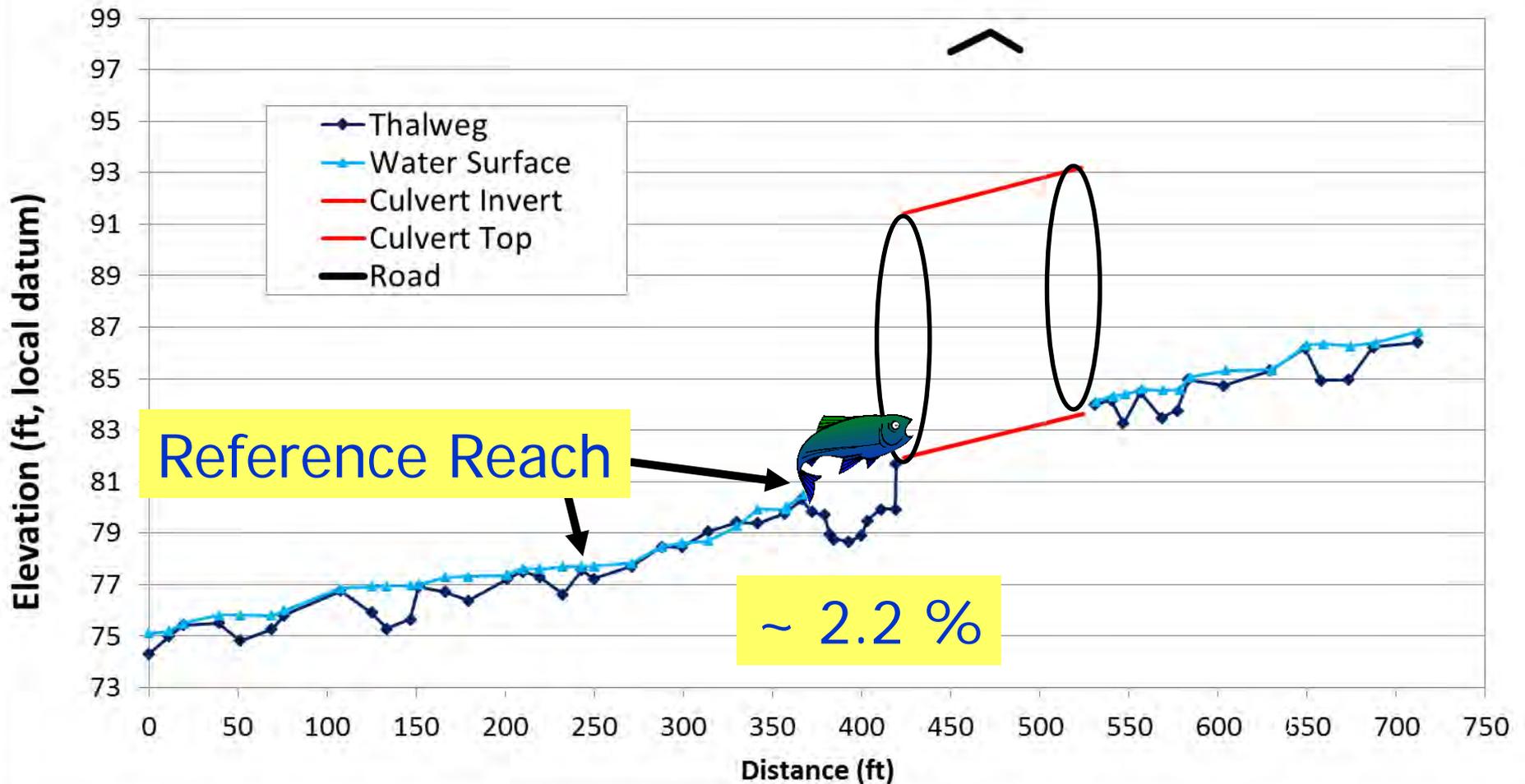
Site sketch



Controlling structures

Profile

Rountree Trib

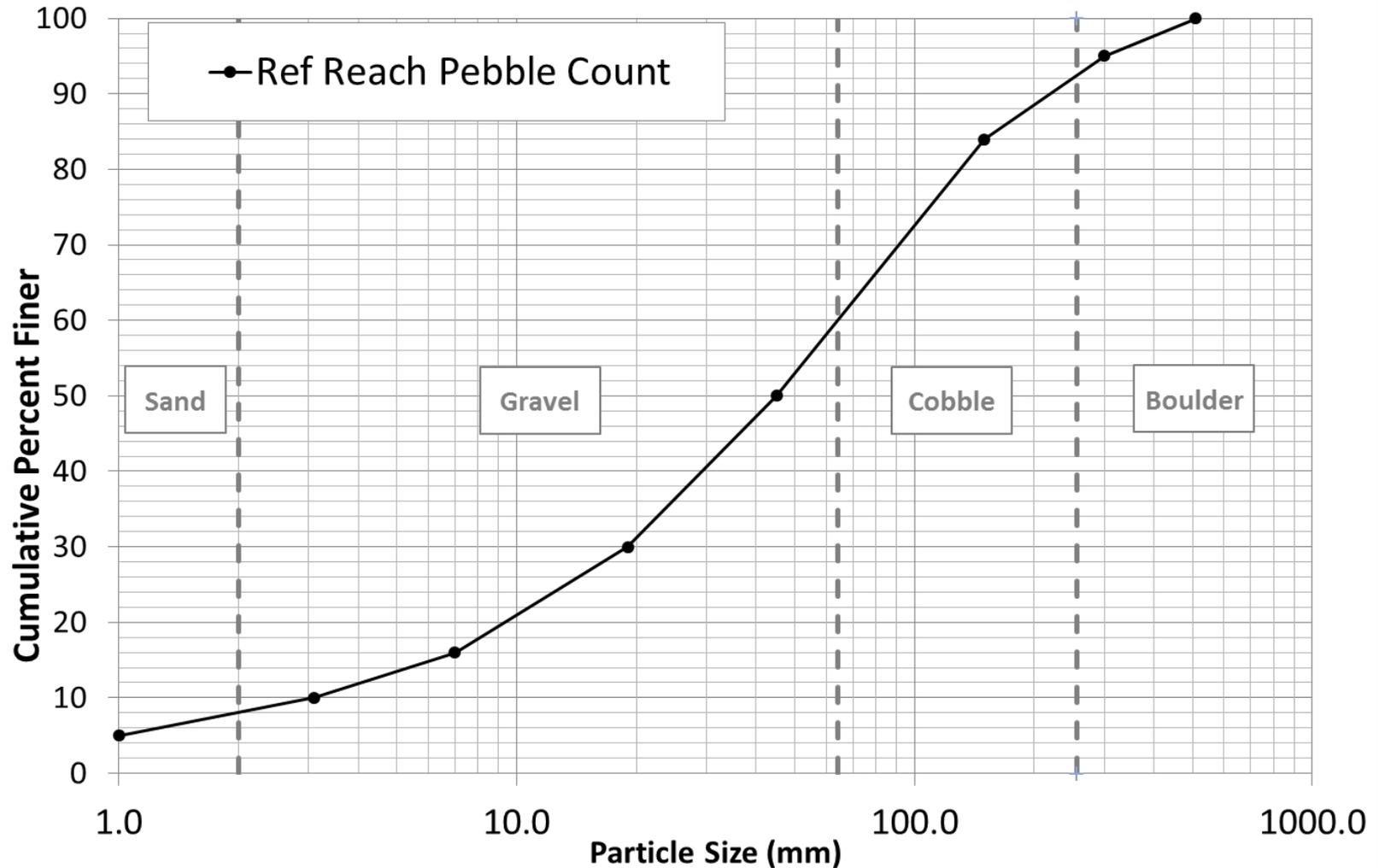


Pebble-count



Rountree Trib. pebble count

Unnamed Trib to Rountree at W Main Street, Platteville, WI



Channel materials: Key pieces

- Measure the largest particles making up key hydraulic features
- Measure between 10 to 25 particles
- Measure the particles, A, B and C dimensions
- Describe the shape and roundness of the particles measured



Site check list

Road/Stream Site Assessment Checklist

Action	Notes
Stream Characteristics	
Reference reach	
<ul style="list-style-type: none"> Cross-sections Bankfull width Substrate Slope/ gradient Roughness elements, key pieces 	
Crossing Impacts	
<ul style="list-style-type: none"> braiding or bank erosion Up or downstream aggradation or scour 	
Channel shape and sinuosity	
Floodplain characteristics (width, soil, veg)	
Fish and aquatic resources	
Public use and navigation	
Road Characteristics	
<ul style="list-style-type: none"> Alignment (vertical & horizontal) Field indicators of problems (overtopping, debris, scour, etc.) Elevations (low point) Surface drainage Ditch drainage Surfacing Available cover Right-of-way (ROW) width Adjacent land ownership & structures Ave Daily Traffic (ADT) 	
Structure Design	
Road alignment (vertical & horizontal)	
Detour	
Structure	
<ul style="list-style-type: none"> Site feasibility for a culvert or bridge Shape Material Height/Width Length Fill cover depth Embankment slope Inlet type (projecting/mitered/headwalls) Elevation Alignment 	

<ul style="list-style-type: none"> Slope Hydraulic capacity check 	
Substrate	
<ul style="list-style-type: none"> Size class distribution Roughness elements, grade controls Grade control Stream banks Bed shape Volume by size class Mobility/stability check Transitions 	
Permitting	
DNR/COE permits & timing restrictions	
FWS migratory bird nesting	
Real estate needs	
FEMA Floodplain mapping	
Other local permits	
Construction	
Site survey	
Traffic control	
Utilities	
Land ownership	
Wetlands & floodplain	
Equipment specifications (type, size, capability)	
Excavation (materials placement, unsuitable)	
Backfill	
<ul style="list-style-type: none"> Material specifications Compaction 	
Erosion control	
<ul style="list-style-type: none"> Diverting surface drainage from site Dewatering Recover organisms Stream diversion & maintaining flow <ul style="list-style-type: none"> Flow volumes Ditch flow Silt fencing Riprap specifications Seed mixture and rate Mulch/erosion control blanket 	
Final site plan	
Monitoring plan	